Delaware Technology Student Association

2020
MODEL ROCKETRY

Delaware Only Competition

"SERVING TECHNOLOGY EDUCATION STUDENTS"
SPONSORED BY THE DEPARTMENT OF EDUCATION

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MODEL ROCKETRY

Overview: Delaware TSA contestants entering the model rocketry competition will design and construct an original scratch built model rocket that must take a standard size "1/2A" engine. Any design is acceptable as long as safety standards are observed when designing and constructing the rocket.

Contest Purpose: The model rocketry contest will provide a means for TSA members to demonstrate their understanding of aerodynamics, the design process, and physics of rocketry through the construction of an original model rocket.

Eligibility for Entry: Entries are limited to one rocket per student. Competition will be for level I (Middle School) and level II (High School). All Rockets must meet safety criteria set forth in the National Association of Rocketry (NAR) Model Rocket Safety Code.

Time Limitations: The contest will run throughout the announced day of the conference.

TSA Regulations & Proceedures:

a. The design theme for this year is “retro”. Examples: (but not limited to) 60’s NASA or 70’s Sci-Fi.
b. Students must prepare a rocket made from "scratch". No kit components are allowed, except for the engine mount and launch lug. All other components are all to be designed and fabricated by the student including the nose cone and recovery system.
c. Any single recovery system style may be used. However, it must be attached to the rocket. If a parachute is used, it must have a hole (or several holes/cut outs) that account for at least 1/2 of the total area of the parachute. Parachutes must be home made. Store purchased parachutes will disqualify the entry
d. All students will bring the completed rocket with a dimensioned engineering drawing that includes the participants ID number to the competition site at time of registration. Note: The definition of drawing means that it is created (manual or CAD) to show relevant views and dimensions. Printouts from RocketSim or other simulation programs are not acceptable.
e. **High School entries** must also submit the Time Aloft Prediction Report that includes the participants ID number to the competition site at time of registration
f. One "1/2A" size engine and electronic launcher will be supplied by Delaware TSA.
g. The rocket's body tube diameter cannot be any larger than 1 1/2" and its body tube length must be between 6” and 12". Body tubes must be home made. Store purchased tubes will disqualify the entry.
h. Weather permitting, all rockets will be launched at conference according to the schedule.
i. Rockets will be launched upon successful completion of a safety inspection. Time aloft points will be earned if the airframe remains intact throughout lift-off, thrust, ejection and recovery modes. **High School entries** must predict time aloft in the Time Aloft Prediction Report where the predicted flight time will be compared with the actual time achieved. A ratio will be computed and multiplied by 10.
j. A student entering the rocketry competition (or their surrogate) must be in attendance for their rocket launch, so they can adjust the angle prior to the launch.

Criteria for Judging:

<u>Please note</u>: Any model rocket that includes components from a kit other than those identified in the regulations will be disqualified.

a. Rocket body production quality - See Contest Rubric
b. Body paint/finish - See Contest Rubric
c. Vehicle Assembly – See Contest Rubric
d. Engineering Drawing – See Contest Rubric
e. Rocket Flight – See Contest Rubric
g. Time Aloft – See Contest Rubric
h. Time Aloft Prediction Points (High School Only) – See Contest Rubric
f. Time of Flight Prediction Report Requirements (**High School Only**) – See Contest Rubric

- Technical Report: Submit on a single page a brief description of the methodology (process) used to predict how long the rocket would stay in the air.
- Contestant ID number must be in the top right-hand corner of report
- Double-spaced Times New Roman, 12pt font
- If a Works Cited page is required, use current MLA format for both the in-text citation and the Works Cited page.
- Predicted flight time compared with the actual time achieved. The ratio computed will be multiplied by 10.

Examples:
1. A rocket that was predicted to stay aloft for 18 seconds recorded an actual time of 20 seconds (18/20 = 0.9 (10% error) 0.9 x 10 = 9 points)

2. A rocket that was predicted to stay aloft for 24 seconds recorded an actual time of 20 seconds (24/20 = 1.2 (20% error) = 0.8 0.8 x 10 = 8 points)

Sample - Time of Flight Prediction Report

Contestant ID # ____________________

Time-Aloft Prediction

Two mathematical models and one flight test were used to determine the model's time of flight. Time to apogee plus descent time is total time. The models had a high correlation of apogee time (5.5 seconds). Impulse was computed at 90% of vendor's value and parachute efficiency was reduced by 25%. An actual flight test time of 24 seconds was 88.8% accurate with a 27 second prediction.

For mathematical model 1, the University of New Mexico's Rocket Altitude Calculator showed that the rocket would reach an altitude of 164 meters or 538 feet in 5.5 seconds (UNM). Based upon:

Motor impulse	2.5 Ns	Burn time	0.8 sec
Rocket mass:	11 grams	Motor mass:	20 grams
Body diameter	1.9 cm	Frontal area	2.75cm^2
Standard temp	21 C	Air Density of	1.225Kg/m^3
Drag Coefficient	0.75	Velocity	75 m/s

Mathematical model 2 using the impulse – momentum equation yields a velocity of 69 m/s and a time to apogee of 5.5 seconds. However, according to Magnus Haw at the University of British Columbia, the tested impulse of A8-3 engines average 2.36+/0.16Ns (Haw 1). Estes Inc. gives the figure at 2.5 +/- 0.25Ns (Haw 5). 2.25Ns being about worst case, this impulse value was used. A higher, more realistic aerodynamic drag factor was also integrated.

Results:	Altitude:	126 meters or 416 feet
	Time to apogee	5.5 s
	Velocity	46.17 m/s

A descent rate was calculated based upon a parachute with an area of 0.0324m^2 using air density and drag coefficient listed above.

Results:	Descent rate	4.4m/s	Descent time	28.6 seconds

However the descent rate is based upon an ideal parachute so this time was factored in at 75% efficiency or 21.45 seconds. Therefore the total flight time would be apogee (5.5s) + descent (21.45s) = 27 seconds.

Works Cited

Haw, Magnus. "A8-3 Model Rocket Impulse Measurement.", University of British Columbia, 10 May 2009, https://open.library.ubc.ca/cIRcle/collections/undergraduateresearch/51869/items/1.0107222 Accessed 4 Aug. 2018.

Rocket Altitude Calculator, University of New Mexico, http://www.unm.edu/~tbeach/flashstuff/RocketAltitudeFixedSize.html Accessed 4 Aug. 2018.